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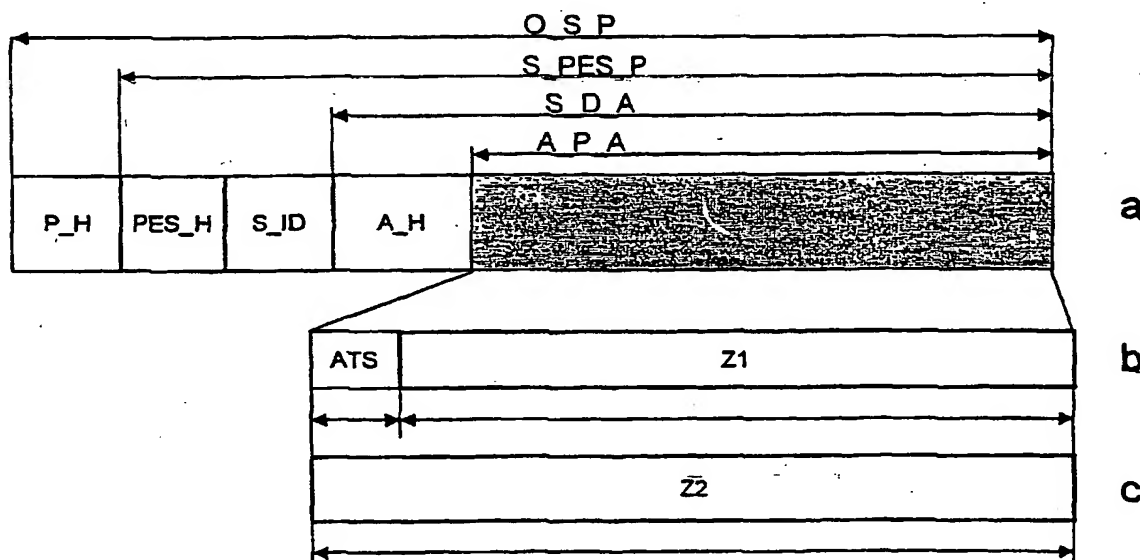
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- (71) Applicant (for all designated States except US):
DEUTSCHE THOMSON-BRANDT GMBH [DE/DE];
Hermann-Schwer-Strasse 3, 78048 Villingen-Schwenningen (DE).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **WINTER, Marco [DE/DE]**; Böhmerstrasse 17, 30173 Hannover (DE).
SCHILLER, Harald [DE/DE]; Apfelgarten 11, 30539 Hannover (DE).
- (74) Agent: **RITTNER, Karsten**; Deutsche Thomson-Brandt GmbH, European Patent Operations, Karl-Wiechert-Allee 74, 30625 Hannover (DE).
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(54) Title: METHOD FOR RECORDING OR PLAYBACK OF LOW BITRATE DATA STREAMS



(57) Abstract: DVD Stream Recording shall be used for realtime recording and playback of given packetized bitstreams. The data of the bitstream are organized into Stream Object Units, which in turn consists of stream packs (O_S_P) with a stream pack header (P_H) followed by a stream packet (S_PES_P), wherein a stream packet (S_PES_P) contains further header data (PES_H, S_ID, A_H) and an Application Packet Area (A_P_A), which is filled with a sequence of Application Packets each prefixed by an Application Time Stamp (ATS). In case of very low bitrate stream recording empty packets are recorded, which are marked as stuffing packets. This ensures that every Stream Object Unit - even in areas where stuffing is performed - contains at least one Application Time Stamp value.

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Method for recording or playback of low bitrate data streams

The invention relates to a method for recording or playback of low bitrate data streams to be recorded or being recorded on a storage medium, e.g. an optical disc.

Background

10

Like the CD also its successor, the DVD (digital versatile disc), can be used for various technical purposes. Therefore, different DVD specifications have been defined, like DVD-Video, DVD-Audio and DVD-ROM for the mass distribution of prerecorded motion pictures, music and software programs, respectively. For recording on DVD discs DVD-RAM and DVD+RW serve for general read-and-write applications in the PC or consumer electronics area, while DVD-R is used for write-once recordable media and DVD-RW is a rewritable version of DVD-R. Still under development is a specification for rewritable/re-recordable DVD discs called DVD Stream Recording, abbreviated DVD-SR. DVD-SR shall be used for realtime recording and playback of given packetized bitstreams, wherein the disc in which data are recorded shall comply with any recordable or rewritable or re-recordable media and file system format prescribed in other DVD specifications.

In general, various packetizing formats of bitstreams are used for different applications depending on the system parameters. The MPEG-2 systems standard as defined in ISO/IEC 13818-1 specifies two different formats, the so-called program stream and transport stream. While the transport stream is used for applications with a relatively high error rate, e.g. the transmission of a DVB data stream via satellite, the program stream is used in

the case of low error rates like data storage.

The structure of DVD-SR recorded bitstreams shall comply basically with the program stream as defined in ISO/IEC 13818-1. The data of the bitstream are recorded as Stream Objects (SOBs), wherein SOBs are organized into Stream Object Units (SOBUs) of a constant size of 64 kbyte. Each SOBU in turn consists of a constant number of so-called stream packs consisting of a pack header followed by a stream packet. A stream packet contains further header data and Application Packet (AP_PKT) data. To each AP_PKT an Application Timestamp (ATS) is assigned. This timestamp enables proper Application Packet delivery during playback.

The time interval captured by a SOBU is not defined but flexible which means that the playback time of a SOBU can vary largely depending on the momentary bitrate of the recorded stream. Therefore, a Mapping List (MAPL) is used for pointing to that SOBU where the desired AP_PKT can be found. Relative time stamps "Incremental APAT" (IAPAT) are assigned to each of the SOBUs corresponding to the time duration of the recorded signal in the respective SOBU. The IAPAT time stamps are derived from times stamps called Application Packet Arrival Time (APAT) which are assigned to incoming Application Packets during recording based on the local reference clock of the DVD-SR.

A limited resolution of 12 bits is used for the IAPAT values, because the MAPL has to be kept in the memory of the streamer device, e.g. a RAM. The maximum IAPAT value corresponds to an upper limit of a SOBU time duration of about 23,3 seconds. This limits the minimum bitrate of a data stream to be recorded to a value of about 5.5 kbit per second.

Invention

It is one object of the invention to disclose a method for recording or playback of packetized bitstreams which is not restricted to the above mentioned minimum bitrate and therefore allows also the recording and playback of very low bitrate data streams. This object is achieved by the method disclosed in claim 1.

10

The invention is based on the recognition of the fact that a DVD-SR should also be applicable for certain applications where very low bitrates occur temporary or even permanently. However, in case of very low bitrate stream recording there could be less than one application packet and therefore less than one ATS per Stream Object Unit. Therefore, according to the current draft of the DVD-SR specification the proper functioning of the Mapping List data retrieval is not guaranteed.

20

According to the invention in the case of very low bitrates empty packets are recorded, which are marked as stuffing packets.

25 The use of these stuffing packets replacing application packets ensures that every Stream Object Unit - even in areas where stuffing is performed - contains at least one Application Time Stamp value. This allows also the recording and playback at very low bitrates, e.g. 100
30 bit/second.

Drawings

35 Embodiments of the invention are described with reference to the accompanying drawing, which shows in:

Fig. 1 the structure of stream packs containing parts of Stuffing Packets.

5 Exemplary embodiments

Abbreviations used for describing the drawing are explained in the following:

10 SOB (Stream Object):

- 1) one take (after editing an origin SOB may be splitted into more than one SOB)
- 2) consists of MAPL_ENT_Ns SOBUs (MAPL_ENT_Ns >= 1; MAPL_ENT_Ns is located in the SOBI of this SOB, i.e. in
15 the IFO file)
- 3) the stream itself consists of SOBUs (located in the SRO file)
- 4) information (location, recording time, start and end time et cetera) about the stream is stored in the SOBIs
20 (located in the IFO file) --> SOBI = SOB Information

SOBU (SOB Unit):

- 1) is stored in the SRO file
- 2) each SOBU consists of 65536 bytes = 32 sectors = 32
25 Stream packs = 32 stream packets
- 3) a stream consists of contiguous SOBUs

AP_PKT (Application Packet):

- 1) is stored in the AP_PKT area of a Stream packet (SRO
30 file)
- 2) an AP_PKT contains the actual payload of the stream
- 2) an ATS (Application Time Stamp) is in front of each AP_PKT
- 3) 1 byte =< AP_PKT size =< 64574 bytes
- 35 4) an AP_PKT starting in AP_PKT area of sector X may end in the AP_PKT area of sector X+Y, with 0=<Y=<31

5) the data of an AP_PKT may even cover a SOBU boundary

APAT (AP_PKT Arrival Time):

- 1) 48 bit time stamp
- 5 2) absolute time stamp
- 3) most exact time stamp of the DVD SR spec
- 4) all other time stamps are sub-sets of an APAT
- 5) the 9 LSB of an APAT describes the 27MHz part of the APAT
- 10 6) the (remaining) 39 MSB of an APAT describes the 90kHz part of the APAT

IAPAT (Incremental AP_PKT Arrival Time):

- 1) element of the MAPL (Mapping List --> see below)
- 15 2) relative time stamp (contains the duration of a SOBU) -
-> it's the only relative time stamp of the spec
- 3) range: $1..2^{12-2}$ (i.e. 5.6ms ... 23.3s) --> 12 bit value
- 4) unit: $IAPAT * 512 / 90000Hz$
- 20 5) $IAPAT\#n$ is
the up-rounded first occuring ATS of $SOBU\#n+1$
minus
the up-rounded first occuring ATS of $SOBU\#n$.
Up-rounding means ceiling($ATS/2^{18}$).
- 25 6) the bits 18 to 29 of an APAT correspond to the 12 bits of an IAPAT

MAPL (Mapping List):

- 1) is stored in the IFO file
- 30 2) each SOBI contains one MAPL
- 3) a MAPL consists of $MAPL_ENT_Ns_IAPAT$ values
- 4) $MAPL_ENT_Ns$ is equal to the number of SOBUs used by this SOB
- 5) MAPL and $MAPL_ENT_Ns$ are located in the SOBI

6) is used to locate an AP_PKT inside the stream (i.e. to locate sector and the start byte of the AP_PKT inside this sector) via a timestamp (APAT)

5 SUM_IAPAT (summation of the IAPATs of an MAPL):

1) is not stored anywhere, i.e. must be calculated by summation of the MAPL entries (IAPATs)

2) is used to find the coarse location of the start of an AP_PKT inside the stream via the timestamp of this AP_PKT

10 3) if X is the timestamp of an AP_PKT we are searching for and

X is between SUM_IAPAT(k) and SUM_IAPAT(k+1), then the searched AP_PKT starts either in SOBU#k or in SOBU#k+1 --> the result of the search is 2 SOBUs exact

15 4) after this coarse search the exact location of the AP_PKT must be found via a direct search inside the stream

5) the bits 18 to 47 of an APAT (i.e. the 30 MSB of an APAT) correspond with SUM_IAPAT

20 ATS (Application Time Stamp):

1) 32 bit time stamp, located in the stream (SRO file)

2) absolute time stamp

3) range: $1..2^{32}-1$ ($1/27\text{MHz} \dots 93.2\text{s}$) --> i.g. wrap
arounds occur inside the stream. I.e. the range of an ATS
25 is too small to be an unambiguous pointer into one whole SOB. Only a complete APAT value is able to be an unambiguous timestamp for a whole SOB.

4) unit of the 23 MSB: 1/90kHz

5) unit of the (remaining) 9 LSB: 1/27MHz

30 6) exact one ATS is at the front of each AP_PKT

7) exact one ATS is at the front of each Stuffing packet

8) the bits 0 to 31 of an APAT correspond to the 32 bits of an ATS

9) the bits 18 to 29 of an ATS have the range of the 12

35 bits of an IAPAT --> of course, IAPAT is relative and ATS is absolute! Therefore, both are not really compareable.

As shown in Figure 1a, a stream pack O_S_P of 2048 byte consists of a stream pack header P_H of 14 byte and a
5 stream PES packet S_PES_P of 2034 byte. The stream PES packet S_PES_P consists of a PES header PES_H of 6 byte, identification data S_ID of 1 byte designating the subsequent payload as Stream Recording Data and a stream data area S_D_A of 2027 byte. The Stream Data Area S_D_A inside
10 a stream packet consists of an Application Header A_H of 9 byte and an Application Packet Area A_P_A of 2018 byte. For normal bitrates the Application Packet Area A_P_A is filled with a sequence of AP_PKTs, each prefixed by an Application Time Stamp ATS. The ATS consists of a 32-bit
15 value and is divided into two parts, namely a base part and an extension part.

In cases of very low bitrate stream recording, stuffing is performed in order to guarantee the proper functioning of
20 the Mapping List data retrieval. For this purpose, a Stuffing Packet is defined as a conceptual unit. The purpose of the stuffing packet is to ensure that every SOBU - even in areas of stuffing - contains at least one Application Time Stamp ATS value. As shown in figure 1 b, in the
25 stream pack containing the start of the stuffing packet the Application Packet Area A_P_A consist of one ATS of 4 Bytes followed by an area Z1 of stuffing bytes. The subsequent stream packs contain the rest of the stuffing packet. An Application Packet Area A_P_A consisting only
30 of stuffing bytes Z2 is schematically shown in figure 1 c.

Stuffing Packets shall fulfill the following rules:

Stuffing Packets always start at the start of the Application Packet Area of the stream pack after the stream pack
35 containing genuine Application Packet data.

Stuffing Packets consist of one ATS of 4 Bytes, followed by as many zero bytes as are needed to fill the Application Data Areas of the remaining packs of the SOBU. Therefore, the total length of a Stuffing Packet is $(4 + 2014 + (n - 1) * 2018)$ Bytes, where $0 \leq n < \text{SOBU_SIZ}$ and SOBU_SIZ is the number of packs in one SOBU.

Although a value of zero for the stuffing bytes may be appropriate for most applications, it is of course also possible to choose other values for filling the Application Data Areas.

The ATS of a Stuffing Packet shall be set as follows:

- in a SOBU where at least one pack contains genuine Application Packet data, the ATS of the Stuffing Packet shall be set to the ATS of the Application Packet preceding the Stuffing Packet;
- in a SOBU where no real Application Packet data are contained, the ATS of the Stuffing Packet shall be set to

$$\text{ATS} = \text{SUM_IAPAT}(k-1)[(31 - \text{MTU_SHFT}).0] * 2^{\text{MTU_SHFT}}$$

where SUM_IAPAT is derived from entries of a Mapping List (MAPL) comprising time stamps assigned to the Stream Object Units and MTU_SHFT is a constant derived from the Stream Object Unit size and the maximum allowable bitrate.

All packs containing Stuffing Packets or parts of Stuffing Packets shall be constructed as follows:

- the System Clock Reference SCR, as specified by the MPEG-2 Systems standard, of the Pack Header shall be calculated according to

$$\text{SCR} = \text{SCR_previous} + 2048 * 8 \text{bits} / 10.08 \text{Mbps},$$

where SCR_previous shall denote the SCR of the previous pack of the DVD Streamer specification;

- the PES Packet Header PES_H and the identification data S_ID shall be specified same as for all other PES Packets;
- the Application Header shall be specified with AP_Ns=0, FIRST_AP_OFFSET=0, EXTENSION_HEADER_INFO=00b, SERVICE_ID=0, MAX_BR_LOG2=0, and SMO_BS_LOG2=0, where these parameters are defined in the preliminary DVD streamer specification.

For the upper limit of the mapping list entries, it has been derived that for all Application Packets i in a SOBU k , the following upper limit must be kept

$$APAT_i[47..18] < \text{sum_iapat}(k-1) + (2^{12} - 2),$$

where $APAT_i$ is the Application Packet Arrival Time of Application Packets i , i.e. an absolute timestamp having e.g. a 48-bit value format.

In order to guarantee that the limitation of this equation is being kept, the following steps or any equivalent operations can be performed during recording:

- a) Upon filling a SOBU with data, memorize the ATS of the first Application Packet (AP), which starts in the current SOBU.
- b) Continuously check the Streamer system clock TSC, whether it fulfils

$$TSC[47..18] < \text{sum_iapat}(k-1) + (2^{12} - 2)$$

- c) As soon as this is violated,
 - c.1) Terminate the current recording sector, using an AP_PKT_Ns value which might be smaller than techni-

cally possible, wherein AP_PKT_Ns is the number of AP_PKTs starting in this Stream Pack.

c.2) Terminate the current SOBU by filling the remainder of the SOBU - if necessary - with a Stuffing Packet as described above; write current SOBU data to disc.

c.3) Create a mapping list entry $IAPAT(k) = 2^{12} - 2$.

c.4) Increment k by 1.

c.5) Start the recording of SOBU#k and open its first sector for recording.

c.6) If an AP_PKT arrives at $TSC[47..0] = SUM_IAPAT(k-1) * 2^{18}$, then proceed to step a)

c.7) Record SOBU#k as a SOBU containing only a Stuffing packet ($ATS = SUM_IAPAT(k-1)[13..0] * 2^{18}$).

c.8) If no AP_PKT arrives during $TSC[47..18] < SUM_IAPAT(k-1) + (2^{12} - 2)$, then proceed to step c.3)

c.9) AP_PKT is the first AP_PKT of SOBU#k+1.

c.10) Set $IAPAT(k)$

c.11) Increment k by 1.

c.12) Proceed to step a)

The application packets may contain any type of data, e.g. video or audio or additional data like service information. The data rate to be handled in the streamer may therefore range up to e.g. an 80 Mbit/s peak data rate value for detailed complexly moving scenes of video signals.

The invention can be used in any apparatus for recording and playback of packetized bitrate data streams, e.g. a so-called DVD streamer. Furthermore, the invention can be used for arbitrary storage media for recording and playback of packetized bitrate streams, especially for DVD discs.

Claims

1. Method for recording or playback of low bitrate data streams, wherein packets of the data stream are recorded
5 in data blocks of constant size and time stamps are used for addressing of the data blocks, the time stamps corresponding to the time duration necessary for a total filling of a data block at the used bitrate, and wherein a maximum time duration is defined corresponding to the total filling of a data block at a minimum bitrate, characterized
10 by that in the case of bitrates below the minimum bitrate empty packets are recorded, which are marked as stuffing packets.
- 15 2. Method according to claim 1, wherein the recorded data are organized into Stream Object Units consisting of stream packs (O_S_P) with a stream pack header (P_H) followed by a stream packet (S_PES_P), wherein a stream packet (S_PES_P) contains further header data (PES_H,
20 S_ID, A_H) and an Application Packet Area (A_P_A), which is filled with a sequence of Application Packets prefixed by an Application Time Stamp (ATS), wherein in the stream pack containing the start of the stuffing packet the Application Packet Area (A_P_A) consists of an Application
25 Time Stamp (ATS) followed by stuffing bytes (Z1) and the subsequent stream packs contain the rest (Z2) of the stuffing packet.
3. Method according to claim 2, wherein a Stuffing
30 Packet starts at the start of the Application Packet Area (A_P_A) of the stream pack (O_S_P) after the stream pack containing genuine Application Packet data.
4. Method according to claim 2 or 3, wherein Stuffing
35 Packets consist of an Application Time Stamp (ATS), followed by as many zero bytes as are needed to fill the Ap-

plication Data Areas of the remaining packs of the Stream Object Unit.

5. Method according to any of claims 2 to 4, wherein the Application Time Stamp (ATS) of a Stuffing Packet is set as follows:

- in a Stream Object Unit where at least one pack contains genuine Application Packet data, the Application Time Stamp (ATS) of the Stuffing Packet is set to the Application Time Stamp (ATS) of the Application Packet preceding the Stuffing Packet;
- in a Stream Object Unit where no real Application Packet data are contained, the Application Time Stamp (ATS) of the Stuffing Packet is set to

15

$$ATS = SUM_IAPAT(k-1)[(31-MTU_SHFT).0]*2^{MTU_SHFT}$$

where SUM_IAPAT is derived from entries of a Mapping List (MAPL) comprising time stamps assigned to the Stream Object Units and MTU_SHFT is a constant derived from the Stream Object Unit size and the maximum allowable bitrate and k is the number of this Stream Object Unit.

25 6. Apparatus for recording or playback of low bitrate data streams according to any of claims 1 to 5.

7. Storage medium for recording or playback of low bitrate data streams according to any of claims 1 to 5.

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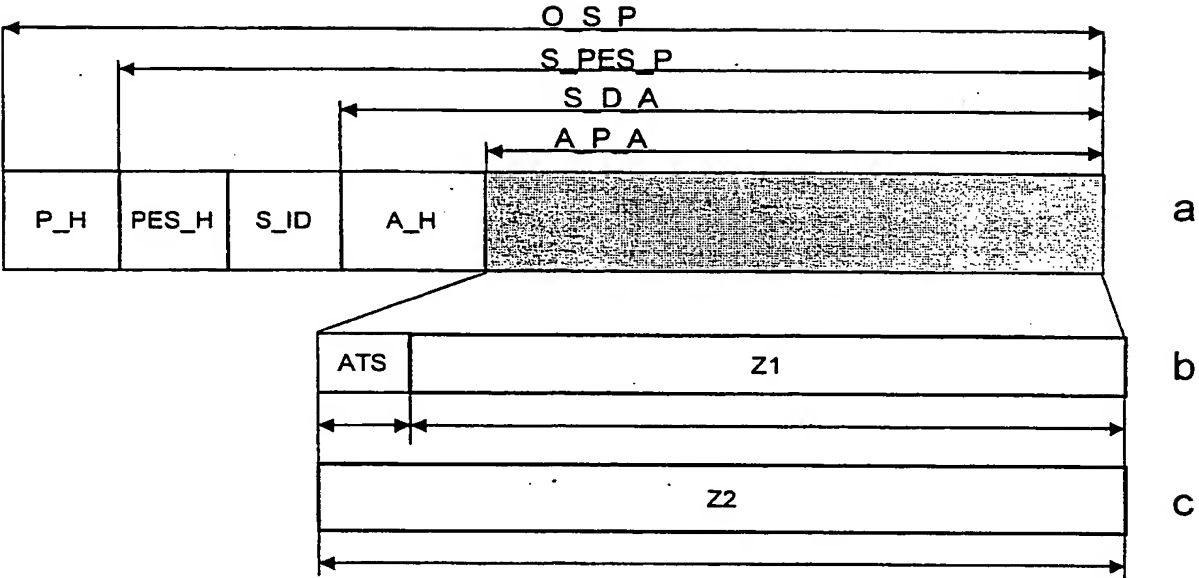


Fig. 1

INTERNATIONAL SEARCH REPORT

International Application No

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A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G11B20/12 G11B27/10 G11B27/30 G11B27/32 H04N7/52
H04N7/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G11B H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, IBM-TDB, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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	-/--	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040. Tx. 31 651 epo nl.
Fax: (+31-70) 340-3016

Authorized officer

Schiwy-Rausch, G

INTERNATIONAL SEARCH REPORT

International Application No

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
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